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AMERICAN FERTILIZER

" That man is a benefactor to his race who makes two blades of grass to grow where but one grew before."

Vol. 95 JULY 5, 1941 No. 1

Phosphoric Acid in Soils, and Fertilizing and Liming Problems in Connection Therewith*

By OLLE FRANCK
(*Abstracted by Firman E. Bear*)

THE content of readily soluble phosphoric acid in the soil which is assimilable by plants changes greatly within comparatively small areas. Even in the vertical direction the difference in the phosphate content is considerable. Thus, in a cultivated field, the phosphate content is usually much higher in the plowed layer than in the subsoil. In a field which is permanently employed as a meadow or pasture, the phosphate content is usually very high at the surface but diminishes rapidly downward.

Most farm soils have a strong tendency quickly to convert phosphoric acid into a difficultly soluble form. Hence, ground water usually has a difficult task in transporting phosphoric acid in the soil. For this reason, phosphoric acid can only be distributed widely and quickly by mechanical means. Phosphoric acid is taken in by the plant roots in the deeper soil layers, carried up to the plant parts located above the ground, and finally restored to the surface.

Retention of Phosphoric Acid by the Soil

Six soils were studied in the following manner: The air-dried soil was pulverized and sifted through a 2-mm. sieve, and then remixed as thoroughly as possible. Eight 100-gram portions of each of the soils were then weighed out, and fertilizer according to Table 1.

The soil was then placed in a glass cylinder 12 inches in height and 4 inches in diameter, and packed down by lightly tapping the cylinder a few times against the top of the table. A coarse filter paper was then placed on the soil and enough water was slowly added from above to saturate the soil to its full capacity. Depending on the type of soil, it took from three (sandy soil) to thirty (clay soil) hours for the water to saturate it. The filter paper was then taken off, and the glass cylinder was left untouched in a room having a temperature of about 20° C. When the water content had dropped to about 30 per cent of the full water capacity (this required an average of about three days), 10 cores of soil were removed from each of the cylinders. Each of these was immediately analyzed for both water- and lactate-soluble phosphoric acid.

Table 1

Fertilizing Plan for Retention Experiments

Experimental Series	Amount of P_2O_5 Supplied: mg. per 100 grams of Soil	Kind of Superphosphate Supplied	
a	0	Pulverized*	Granulated**
b	2	Pulverized*	Granulated**
c	4	Pulverized*	Granulated**
d	8	Pulverized*	Granulated**

*The pulverized superphosphates were most carefully rubbed together with the soil in a large porcelain mortar with the help of a porcelain pestle.

**The granulated superphosphates were not rubbed together with soil, but were carefully mixed therewith with the help of a piece of pasteboard to avoid crushing the phosphate particles.

Of the phosphoric acid added in the water-soluble form, less than 7 per cent was afterward found in this form in very acid soils;

*Meddelande Nr 483 från Centralanstalten för försöksväsendet pa jordbruksomradet. Jordbruksavdelningen Nr 106.

between 7 and 10 per cent in an almost neutral loamy soil; and between 14 and 20 per cent in an alkaline sandy soil. The phosphate content of the water extract probably gives a fairly good idea of the phosphate concentration in the ground water. Thus, the phosphate concentration was not changed to any appreciable extent by the phosphate fertilizing, except in the alkaline sandy soil. In the latter there was such a large increase in the phosphate content that the growth process might have been adversely affected due to excessive phosphate concentration, and there might have been a waste of phosphate by leaching.

The plant can easily take in phosphoric acid from a highly dilute solution. Only when the phosphate concentration goes below 1 mg. per liter does the absorption of phosphate become difficult. From the standpoint of the fertilizing requirements, the phosphate concentration is usually of comparatively small importance. The principal problem is whether or not the phosphoric acid which has been taken in by the plants from the ground water can be replaced quickly and constantly enough. The ability of the soil to supply the ground water with phosphoric acid quickly and constantly enough is what really determines the phosphate condition from the standpoint of plant nourishment.

It has been found that Egner's lactate method (Egner: Meddelande nr 425, and Franck: Meddelande nr 428 fran Centralanstalten) gives a good idea of the amount of plant-soluble phosphoric acid which is available to the plants.

Between 15 and 17 per cent of the added water-soluble phosphoric acid remained in the lactate-soluble form in an acid silt loam; between 29 and 32 per cent in an acid sandy soil; between 28 and 31 per cent in an acid loam; between 30 and 36 per cent in a less acid sandy soil; between 27 and 42 per cent in a nearly neutral loam; and between 62 and 63 per cent in an alkaline sandy soil. In all of the soils, relatively higher values were obtained for larger phosphate doses.

The differences between maximum and minimum values were much greater for the granulated superphosphates than for the pulverized superphosphates. In the employment of granulated phosphate it was found, in every instance, that many of the soil cores showed practically the same values as the soil cores taken from unfertilized cylinders, while other soil cores showed values several times greater than those found for the pulverized superphosphates. The granulated phosphate was strongly retained where it lay, and the phosphoric acid did not spread out from it to the more distant parts of the soil even when large amounts of water are added.

Root Development Following Phosphate Fertilization

The phosphate fertilizers which are usually used in Sweden are superphosphate and Thomas phosphate, or slag. Both of these fertilizers are on the market in the finely divided form. However, superphosphate would be more suitable in the granulated form. The finely-divided superphosphate reacts much more quickly and extensively with the soil than the granulated superphosphate, thereby losing more quickly than the granulated form its ability to supply phosphoric acid to the plants. The large particles are able to saturate soil zones in such a way as to enable the roots easily to take in the phosphoric acid. The phosphoric acid which has been taken in can be replaced from the supply which has not yet completely reacted with the soil, that is, from the phosphate particles themselves. The granulated phosphate is a more stable phosphate and provides a more constant supply of phosphoric acid in the soil.

When the phosphate is employed in the granulated instead of in the finely pulverized form, only a part and not the whole of the soil is fertilized; that is, the part in which the plants have most of their roots which take in the nourishment. Of course, if a sufficient amount of phosphate fertilizer is applied over a number of years in succession, then the final result is the same whether the superphosphate is applied in the granulated or in the finely divided form. In both cases the soil is finally saturated with phosphorus throughout its mass to such an extent that it is in the best condition from the standpoint of plant nourishment. In applying it in the granulated form, a larger part of it should be used up in a shorter time. This is very important, for most farmers do not have a very large amount of working capital. Many farmers would, therefore, find it economically impossible to supply all at one time the large amounts of phosphate which would be required to put their whole soil mass into the best phosphate condition. At the same time, it might even result in harm and in losses of phosphoric acid to supply very large amounts all at one time. The granulated superphosphate, therefore, has a considerable advantage from the technical standpoint. It is drier, does not destroy the sacks, and is not so likely to cake together. The granulated

form is also easier to spread, whether by hand or by machine.

In order to study how the root system of a plant develops when superphosphate of different degrees of fineness is placed in different layers of the soil, a series of experiments were started in the greenhouse on March 24, 1937, moved out into the field at the end of April, and terminated on June 1 and 2, 1937. The planting containers employed were wooden boxes 12 inches in height, 6 inches in width, and 26 inches in length. One of the long sides could easily be unscrewed in the longitudinal direction of the box; and two inches back from the removable long side a windowpane was inserted. In order to provide thorough ventilation, as well as access of water from below, a large number of holes were bored through the bottom. The water was provided from below by placing the box for a certain length

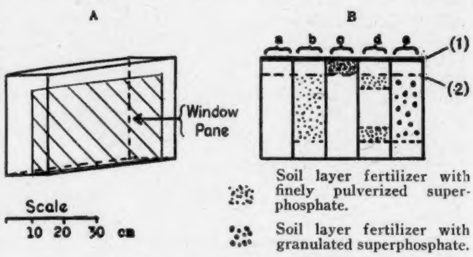

FIG. 1. (A) Growing box and (B) Diagrammatical experimental plan. (1) Layer of quartz gravel. (2) Sowing depth. Amount of phosphate in each box (except box A) corresponds to 535 lb. of 20% superphosphate per acre.

of time in a shallow zinc tub where the water was one to two inches high. In order to prevent the topmost soil layer from drying out, the soil was covered with a thin layer of coarse quartz gravel.

The moisture of the soil when it was put into the boxes was satisfactory for germination. Three and six weeks after sowing, it was watered by sprinkling, each time with an amount of water corresponding to 1 inch of rainfall. The watering from below—by placing the box in the zinc tub for three days—was undertaken whenever there was noticed any tendency to droop. One-half of each box was sowed with Seger oats and the other half with golden barley. The experiment was terminated when the grain was about to go into spikes. The windowpane was taken out, and the loose soil particles were carefully washed with water to expose the root system (See Fig. 1).

Two different types of soil were employed in the experiment, one a humus-bearing silty loam (pH value, 5.1; lactate index, 1.7), and the other a humus-poor sandy soil (pH value, 5.4; lactate index, 0.8). The findings were fundamentally the same for both types of soil. The growth was very uniform and satisfactory. Very soon there could be observed definite differences between the different fertilizing treatments in the boxes. The unfertilized ones, and the surface-dressed ones, were soon behind the others. In the case of oats, full stemming was observed in the deeply fertilized box several days later than in the barley. During the same time, the unfertilized oats had developed only two blades, and the surface fertilized oats had developed only three blades

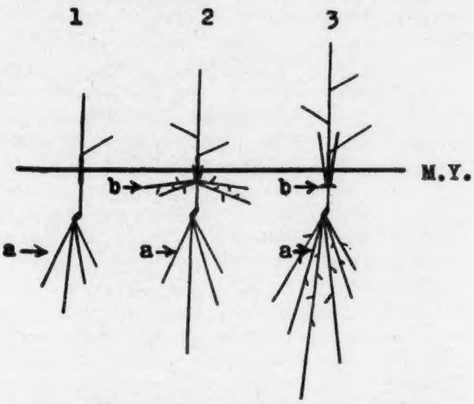

FIG. 2. Diagrammatic representation of root development with the phosphate fertilizer disposed at various depths. Same sowing time for all of the specimens. The figures show the root development at the same time after sowing. Good moisture throughout the whole soil mass all the way up to the surface.

1. No phosphate fertilizing. Only seed roots developed (a), no crown roots.
2. Soil layer above the seed phosphate-fertilized. Both seed roots (a) and crown roots (b) developed.
3. Soil layer under the seed phosphate-fertilized. Only an indication of crown roots (b), but seed roots (a) strongly developed.

M.Y. indicates surface of soil.

with the beginning of stemming. The plants were thinned out on the same day from 15 to 6 of each kind of grain. In thinning out the oats, care was taken to observe any differences in root development due to differences in the experimenting procedures. The distance between the seed and the base of the stem was comparatively great in all of the specimens. In none of the unfertilized specimens was there observed any beginning of crown roots, while such a development was observed in the case of the deeply fertilizer specimens. In the surface fertilized specimens there were several

(Continued on page 22)

North Carolina Issues Official List of Grades

Under the new North Carolina Fertilizer Law, which becomes effective December 1, 1941, the North Carolina Board of Agriculture and the Director of the Agricultural Experiment Station are empowered to set up a list of grades of fertilizer, ranging from a minimum of 35 to a maximum of 50, which can be sold in the State during 1942.

On June 16th a conference was held which was attended by representatives of the fertilizer industry, the State College, the Grange, the Farm Bureau as well as experiment station, extension and vocational agricultural workers. This conference unanimously voted in favor of limiting the list of official grades to the minimum of 35 and proceeded to prepare a list. With but minor changes. this list was adopted by the Board of Agriculture and the Director of the Experiment Station on June 27th, the number of grades totaling 36, due to the fact that the Tobacco Work Conference had not made a specific recommendation for a grade to be used on plant beds. Of the 36 grades adopted, 25 are recommended by the Agricultural Experiment Station.

The official list of grades, which can be sold during the year beginning December 1, 1941 and ending November 30, 1942, are as follows:

0-8-8	*3-8-8	*5-7-5
*0-8-16	3-8-10	5-7-7
*0-10-6	*3-10-6	†*5-8-3
*0-12-12	3-10-10	*5-10-5
*0-14-6	*3-12-6	*5-0-20
*2-8-10	*4-8-4	*6-6-5
2-10-4	*4-8-8	6-6-15
*2-10-6	†*4-9-3	*6-8-6
*2-12-6	*4-10-4	6-10-15
3-8-3	*4-10-6	*10-0-10
3-8-5	*4-12-4	*10-0-15
*3-8-6	4-16-4	12-0-6

* Recommended by the Agricultural Experiment Station.

† Tobacco plant bed; subject to the approval of the Tobacco Work Conference.

Red Tag on Low Grade Mixtures

The new law requires that, on mixtures containing less than 16 per cent plant food, a red tag about 2¼ by 4½ inches must be attached to each bag or package, to call attention to the fact that the contents are officially "low-grade." As the only grade in the above list which contains less than 16 per cent plant food is the 3-8-3, the red tags will be needed for this grade only. However, as this grade has had the largest sales for a number of years, there will probably be quite a number of red tags in evidence during 1942. The State Authorities are urging the fertilizer industry to push the grades recommended by the Experiment Station and thus reduce the tonnage of the 3-8-3 and 3-8-5 analyses. It is to be noted that the official list contains very few of the highly concentrated fertilizers, 31 per cent being the greatest content of plant food in any analysis.

DEL-MAR-VA ASSOCIATION HOLDS ANNUAL MEETING

The 21st annual convention of the Del-Mar-Va Peninsula Fertilizer Association was held June 28th at Rehoboth Beach, Del. In the absence of President Enos Valliant, Irvin Brumbaugh, Vice-President, presided. Charles J. Brand, of the National Fertilizer Association, spoke on "War and Post-War Problems," and Leon Walker of Wilmington, Del., representative of The National Association of Manufacturers, spoke on "Industry's Role in Our Defense Program." W. S. Rupp, John P. F. Ritz, and H. R. Smalley made brief informal remarks concerning soil improvement work. Special guests who were present and who were introduced were: H. H. Hanson, State Chemist of Delaware; Dr. L. B. Broughton, State Chemist of Maryland; Dr. C. H. Mahoney, Head of the Department of Horticulture, University of Maryland; and John Magruder, Extension Agronomist, University of Maryland. The meeting was well attended.

GRAIN DEALERS DISCUSS FERTILIZER BENEFITS

About 250 persons attended the annual convention of the Indiana Grain Dealers Association, French Lick, June 16-17. H. R. Smalley, of the National Fertilizer Association, speaking on "Progress in the Manufacture and Use of Fertilizer," sketched briefly the more recent developments and stressed the fact that much progress has been made in Indiana in eliminating unnecessary grades and in increasing the plant food content of fertilizers. Opportunities for increasing sale of fertilizer were pointed out, especially on the fall wheat crop. The present rate of application on wheat is approximately 160 pounds per acre. If each wheat grower would increase his application to 250 pounds it would mean an increase in the State's total fertilizer consumption of over 50,000 tons. This would add 4 or 5 million bushels to the State's total yield, improve the quality of all the wheat, and produce a better clover crop following the wheat.

Tomato Plant Production in the South

By JACKSON B. HESTER*

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(Continued from the June 7, 1941, issue)

Trace Elements

In 1941 a series of tests was conducted for trace element deficiencies, since zinc deficiency, "white bud," had been seen in corn fields adjoining the tomato plant fields. Furthermore, a number of tests for boron deficiency were carried out on soils from these sections using the sunflower as a test plant (see Fig. 5). A surprisingly high number of samples showed boron deficiency symptoms. One grower has used borax in some of his fertilizer on the soils that showed these symptoms and found the tests to be reliable. In other words, he obtained better crops where the borax was used. However, our fertilizer mixture containing trace elements did not show any great improvement over the standard formulas for tomato plants. It is believed, however, that from 5 to 10 pounds of borax and a like amount of zinc sulphate per ton of fertilizer would be worthwhile. No information at this time would indicate that copper or manganese would be of any benefit.

Varying Analyses

Other work in 1941 included some slight variations in analyses. These data are given in Table 4. The formulas were prepared from the same materials used in the aforementioned mixtures.

In passing it might be stated that the 4-8-8 mixture was outstanding in one of the fields. This was probably due to the large amount of limestone in the mixture (470 pounds to the ton). It might be further pointed out that plants from the plats which had limestone used in conjunction with the fertilizer mixture (1,000 pounds to the ton), while they were not rated high in Georgia, carried very well in shipping. All were rated good in New Jersey. This indicates further that calcium, magnesium, and phosphorus give body to the plants.

It is believed that at least a part of the fertilizer should be placed a little deeper in the soil than is commonly done because during dry weather plants often suffer from a lack of plant food, even though it is present in the

Table 4

The Results of Different Analyses of Fertilizer Upon the Yield of Plants

Fertilizer Analyses	No. Plants per Acre	Green Weight of Plants in Pounds	Wt. in Pounds of 125,000 Plants	Observed Rating: Georgia	Observed Rating: New Jersey
		ORANGEBURG SANDY LOAM			
3-12-6	305,000	3,438	2,188	2+	1
4-12-8	227,500	2,500	1,875	1	2+
4-8-8	277,500	3,438	1,875	2	1
4-12-4	405,000	3,750	1,719	2+	2
4-8-8 and limestone*	442,500	3,125	1,406	2	2+
3-12-6 and limestone*	367,500	3,594	1,875	2	1
4-12-8 and limestone*	365,000	3,750	2,344	1+	1
		TIFTON SANDY LOAM			
3-12-6	427,500	3,906	1,719	2	2
4-12-8	355,000	3,281	1,875	3—	1+
4-8-8	327,500	4,063	2,188	3	1
4-12-4	347,500	4,531	2,344	2	1
4-8-8 and limestone*	480,000	5,000	2,188	3	2
3-12-6 and limestone*	430,000	5,000	2,500	3	1
4-12-8 and limestone*	297,500	3,125	2,188	3	1

*1,000 pounds of limestone mixed with each ton of fertilizer.

dry topsoil. One such case was thoroughly investigated in 1941. There was available plant food in the dry topsoil but where the roots were there was little plant food available. It is true than an extremely deep root system is not too desirable as these roots may be stripped from the plant in pulling. If a small amount of soluble plant nutrients could be put in with the seed and the bulk deeper, the above condition may be avoided. It is further believed that better methods of distributing the fertilizer could be developed.

Pulling and Handling Plants

The author has seen so many good plants lost from improper methods of handling that a few statements here may not be out of place. The illustration in Fig. 6 shows a properly packed bundle of plants and a desirable type of basket for shipping same. The above material was taken from a car in New Jersey. See Fig. 7.

FIG. 5. Plant tests with sunflowers show that a number of Georgia soils are low in boron.

It is believed that packages carrying 50 plants arrive at their destination in the best condition. Adequate paper should be used to hold the plants together. There should be plenty of moist, not soggy, peat moss used. The peat moss should be spread over the roots and not placed on the stems above the roots in one mass. It is desirable to place the baskets of plants in a cool shady place, after packing, for a short time as the plants should be cool when they are placed in the cars.

Packing Materials

Previous to the war, German peat moss was largely used as a packing material. Since the supply of this material has been restricted, various packing materials have been proposed. The importance of having a suitable material for packing the plants cannot be over-emphasized, for although this is a minor detail it markedly influences the condition of the plants when they arrive at their destination.

There are a number of requirements for a suitable packing material that must be met. The material must contain no foreign chemicals that are toxic or injurious to plant development; it must have a high water-holding capacity and give up this water slowly but completely to the plants; it must be fluffy when dry, spongy when wet but not soggy or too fine. In other words, the material should have life and spread easily on the roots of the

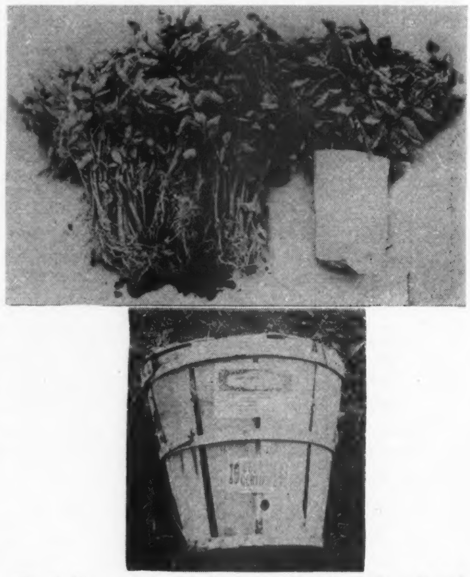

FIG. 6. Two excellent bundles of plants shipped from Georgia after they arrived in New Jersey. The five-eighths basket shown is a desirable container for shipment.

FIG. 7. Types of fast express cars used in shipment of plants being unloaded in New Jersey.

plants. The material should not ferment or undergo decomposition in the package, and it must be readily accessible and economical. No material is likely to completely meet all of these requirements. The German and Scottish peat moss come as near fulfilling these requirements as any materials handled, except for accessibility and cost. The third best material examined comes from the Maine bogs but since this section is so cold and freight

rates are so high, this material is rather inaccessible.

In Georgia there are a number of localized deposits of peat and sphagnum moss. These materials are accessible and, if cheap methods of getting them out of the swamp can be perfected, these may prove a satisfactory packing material. Peat is not a dead inert body and its physical and chemical condition is greatly influenced by the method by which it is handled after being taken from the bogs. If it is dried too completely and at too high a temperature, it becomes lifeless and will not reabsorb water. Consequently the method of drying and grinding the peat taken from the bogs is highly important. Several of the samples of the Georgia peat appear to be satisfactory as a packing material while several others appear to be entirely unsatisfactory. Undoubtedly this is a result of the way the samples were treated before being shipped. Sphagnum has one or two objections; it tends to ferment in the package and to give up the moisture too rapidly. Spanish moss tailings appear to be a satisfactory material for packing. However, some of this material carries too much sand. Combinations of this with

(Continued on page 26)

Table 5

Experimental Data Regarding Plant Packing Materials

Source	Fineness Dry	Appearance Dry	Appearance Wet	Rate of Moisture Absorption
1. German peat moss	Medium	Fluffy	Spongy	Slow
2. Georgia peat	Coarse	Caked	Lifeless	Moderately rapid
3. Georgia peat	Fine	Fluffy	Soggy	Slow
4. Scotch peat moss	Medium	Fluffy	Spongy	Slow
5. Georgia sphagnum	Very coarse	Undecomposed	Spongy	Very rapid
6. Florida Spanish moss tailings	Fine	Sandy	Moderately spongy	Rapid
7. Florida Spanish moss tailings	Fine	Sandy	Moderately spongy	Rapid
8. Georgia peat	Coarse	Caked	Lumpy	Moderately rapid
9. Georgia peat	Medium	Fluffy	Soggy	Rapid
10. Georgia peat	Medium	Fluffy	Soggy	Rapid
11. Maine peat	Medium	Fluffy	Spongy	Moderately rapid
13. Cane fiber	Fine	Fluffy	Soggy	Rapid
12. Michigan peat	Medium	Fluffy	Moderately spongy	Moderately rapid

Table 6

Experimental Data Regarding Plant Packing Materials

	Color Dry	Color Wet	pH	% N	% Ash	% Loss on Ignition	% Water of Air Dry Product	No. Times Weight Absorbed in Water	Relative Moisture Content of Plant when Unpacked	% Water in Peat when Unpacked	Rating
1.	Brown	Cork brown	4.0	1.27	1.7	98.3	13.0	10.0	93	60	A
2.	Brown	Black	4.05	3.60	4.1	95.9	9.0	3.6	90	45	C
3.	Chestnut brown	Brownish black	4.4	3.50	5.0	95.0	6.4	8.4	100	28	B
4.	Brownish black	Brownish black	3.4	1.13	1.6	98.4	12.3	4.7	83	50	A
5.	Greenish brown	Greenish	4.1	1.48	15.8	84.2	10.4	8.4	89	9	B
6.	Grayish brown	Black	6.8	0.97	45.7	54.3	8.1	4.7	79	10	B
7.	Grayish brown	Black	6.85	1.01	42.5	57.5	8.7	4.0	74	9	B
8.	Reddish brown	Brownish black	4.0	2.80	7.2	92.8	11.0	6.0	92	61	C
9.	Brown	Black	3.9	1.51	6.6	93.4	8.1	6.6	79	52	A
10.	Blackish brown	Black	4.05	1.90	7.3	92.7	6.0	6.0	79	51	B
11.	Brown	Brown	4.05	1.60	1.50	98.5	19.0	5.2	...	...	A
12.	Reddish brown	Brownish black	4.75	2.40	4.0	96.0	30.0	3.3	...	...	C
13.	Straw color	Straw color	5.15	0.40	4.7	95.3	6.0	17.0	...	...	C

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Principal Articles in This Issue

Settle the Potash Strikes!

At its meeting on June 26th, the North Carolina Board of Agriculture adopted the following resolution:

"Whereas, agricultural production constitutes one of the first lines of defense, and

"Whereas, economical applications of fertilizers are necessary to normal crop production, and

"Whereas, necessary foods for human consumption are essential to the successful continuation of the National Defense programs of the Nation, and

"Whereas, farmers of North Carolina and the Nation are faced with a shortage of one of the essential plant foods, namely potash, which is supplied as an ingredient in commercial fertilizers, since the production of this material in the United States has been curtailed as a result of strikes in two major potash producing plants.

"Therefore, be it resolved that the North Carolina State Board of Agriculture, in session June 26, 1941, hereby petition the President of the United States and the Congress of the United States to make immediate investigation and take necessary action to assure delivery of such potash as may be essential for the general welfare of agriculture and the Nation.

"Be it further resolved that a copy of this resolution be sent to the chairman of the agricultural committees of Congress and all congressmen and senators from North Carolina."

While possibly the production of potash cannot be included among the "Defense" industries, under a strict interpretation of the law, the plea of the North Carolina Board should have the support of every patriotic American.

The domestic potash industry has been created in a remarkably few years and in the face of difficulties which would have made many a business pioneer hesitate. Limited to a world competitive price, because of lack of tariff protection, the industry has responded to the demands of the war emergency. Prices have not been allowed to "skyrocket" as they did during the first World War, and every means has been adopted to see that our potash production was kept out of speculative hands.

Without attempting to pass judgment on the matters in dispute between the companies and their employees, our government should do its utmost to see that a fair settlement is reached which will permit the potash industry to develop to the extent that an adequate supply of this vital material is assured, not only for the present emergency but during the years to come.

Egypt's Agriculture Affected by Lack of Fertilizers

The spread of the war to the Eastern Mediterranean is seriously affecting the Egyptian agricultural economy, the United States Department of Agriculture has reported. Unlike the situation in 1914-1918, however, Egyptian food supplies are ample and no drastic shifts in crop production have been found necessary to date. There is no rationing of foodstuffs, the only products so far rationed being kerosene and fertilizers.

The Department report, "Wartime Aspects of Egyptian Agricultural Economy" prepared by Dr. N. William Hazen, appears in the June issue of Foreign Agriculture, monthly publication of the Office of Foreign Agricultural Relations. The report states that the disruption of shipping in the Mediterranean has caused a severe decline in Egyptian foreign trade. Exports, which are normally made up almost exclusively of farm products, have now come practically to a standstill. The same is true with respect to imports of badly needed fertilizers, farm machinery, and other manufactured products.

Egypt is finding it increasingly difficult to obtain from abroad goods not normally produced in the country. This is especially true with respect to fertilizers. Because of the widespread use of irrigation practices which eliminate the depositing of river sediment, the country's farm output is entirely dependent on the use of large quantities of imported nitrogenous fertilizers. Prior to the war, Egypt obtained about half of its fertilizer imports from Germany and countries now under German domination, and the remainder chiefly from Chile, the United Kingdom, and the United States.

The acuteness of the fertilizer problem is mounting in proportion to increased dislocations in shipping, according to the report. Although present small stocks may enable Egyptian agriculture to squeeze through the summer without seriously endangering soil fertility, the situation may become precarious in the fall, unless substantial quantities can be imported or a drastic change is made in Egyptian farm production.

V-C PROMOTES HUNTER

On July 1st the Virginia-Carolina Chemical Corporation promoted M. E. Hunter to the position of general sales manager. Mr. Hunter has been connected with the company since 1923, serving as salesman, assistant manager and manager of the company's offices at Columbia, S. C., and Montgomery, Ala.

MAY SULPHATE OF AMMONIA PRODUCTION INCREASES

After a slight drop during April, the production of by-product sulphate of ammonia increased during May to the established level of about 2,000 tons per day. According to the U. S. Bureau of Mines, the output during May was 61,495 tons, an increase of 6.2 per cent over April figures of 57,917 tons, and about the same advance over the 57,781 tons produced in May, 1940. For the first five months of the year, the output was 306,964 tons in 1941 and 282,602 tons in 1940.

By-product ammonia liquor showed an output of 2,679 tons in May, 1941, an increase of 3.7 per cent over April. For the January-May period, production totaled 13,012 tons in 1941 and 11,353 tons in 1940.

RESCH NAMED VICE-PRESIDENT OF I. A. C.

Robert P. Resch, treasurer of the International Agricultural Corporation, has been elected to the office of vice-president, and will serve as vice-president and treasurer. John E. Bierwirth, vice-president of the New York Trust Co., was elected a director, succeeding Albert H. Wiggin who recently resigned.

OHIO RAISES PLANT FOOD REQUIREMENTS

A bill amending the Ohio Fertilizer Law has been passed by the Legislature and approved by the Governor. Effective September 4th, fertilizers offered for sale in the state must contain a minimum of 18 per cent plant food. The new law also makes some minor changes in other provisions.

AIR IN SOIL NECESSARY FOR FULL FERTILIZER VALUE

The poor showing of fertilizers on many soils in Ohio has been traced to insufficient air in the soil, reveals Byron T. Shaw of the Agronomy Department of the Ohio Agricultural Experiment Station. This reduced air capacity has been brought about by too frequent cropping to clean-cultivated crops and too little return of organic matter to the soil.

Plants cannot live on nutrients alone. Light,

temperature, air, and water also play important roles in plant growth. If there is to be efficient utilization of nutrients by the plant it is necessary that all growth factors be favorable.

Recent experiments carried out by the Ohio Agricultural Experiment Station show that it is possible to increase the air capacity of soils by growing legume-grass mixtures in the rotation, by returning all plant residues to the soil, and by using liberal applications of manure. Soils that previously showed little or no response to fertilization (0 to 1 ton of increase in sugar beet yield) have given excellent returns for the fertilizer applied (4- to 6-ton increase in beet yield) when the air capacity was increased.

GUARDING BRITAIN'S CORNFIELDS

With 12,500,000 acres under the plough this spring—3¾ millions more than in 1939—Britain's agricultural leaders are planning how to protect her corn crops from Nazi fire bombs.

Last year Germany's air onslaught did not develop fully until the harvest was gathered in, but this year, combined with U-boat attacks on shipping, the menace to British food supplies is very real.

Among the safeguards which may be enforced is the cutting of fire-breaks or lanes, about 30 ft. wide, across the direction of the prevailing wind. The crops, cut green, would not be wasted, but made into hay or silage. Corn stooks can be protected by setting the rows as far apart as possible. Ricks would be set at least 15 yards apart, and, preferably out in the field, to prevent enemy landings.

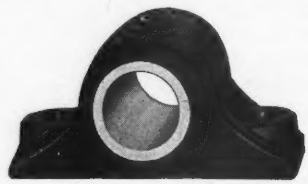
For dealing with outbreaks of fire, water carts would be kept filled near the standing crops, and further reserves stored in ricks or van covers supported on stakes.

Fire-fighters will arm themselves with stirrup pumps, fruit spraying machines, liquid manure carts, wet sacks and brooms cut from timber and hedgerows. Tractors will be useful for ploughing a fire-break quickly in the path of an advancing fire, and scythes for isolating small patches.

With fire-watchers, A. R. P. wardens and Home Guards in every parish, there will be no lack of man-power to safeguard the vital harvest of 1941.

JEFFREY BRINGS OUT NEW LINE OF BEARINGS

A new and improved line of solid and split journal bearings, carried in stock and neatly cased and labeled for prompt delivery, is announced by The Jeffrey Manufacturing Company, Columbus, Ohio. Of accurate dimensions with modern rounded lines and smooth gun metal finish, these precision-made bearings have machined bases and faced ends. Height



to center line of shaft is rigidly maintained. The babbitted bores are broached to smooth hard surface and require no "wearing in."

Both styles are tapped for grease cups or pressure fittings. An ample storage groove in the top provides proper distribution of lubricant. In addition, the split bearing has feeder grooves on each side. Individual containers are furnished for easy handling and protection in shipping.

FERTILIZER MATERIALS MARKET

NEW YORK

Second Increase in Superphosphate Prices Recorded with Further Increase Probable. Strike may Curtail Available Potash Supplies.

Exclusive Correspondence to "The American Fertilizer."

NEW YORK, July 1, 1941.

As indicated in the last issue, price of superphosphate was increased by $1.00 per ton with a subsequent further increase of 50 cents per ton, bringing prices to $9.50 for run-of-pile and $10.00 for guaranteed 16 per cent grade.

Demand is fair, but with the difficulty of obtaining raw material, stocks are reported low and it is quite likely that further advances may be made.

No new seasonal prices have as yet been announced for Chilean nitrate of soda. Some spot sales are being made on the basis of old prices.

The strike at the plant of one of the larger potash manufacturers has not as yet been settled and the loss of production due to this strike has naturally upset all calculations on available potash in this country.

Organic ammoniates have been very firm with slightly increased prices. Demand has been increasing.

Early catches of Chesapeake fish have been large and the market is now $4.50 ($5.47 per unit N) and 10 cents, and is firm.

BALTIMORE

Freight Increase on Phosphate Rock Causes Sharp Advance in Superphosphate Price. Rationing of Sulphate of Ammonia Feared.

Exclusive Correspondence to "The American Fertilizer."

BALTIMORE, July 1, 1941.

The outstanding feature during the past two weeks in the market on fertilizer materials is the firmer market on superphosphate, which had been expected for sometime past.

Ammoniates.—The market on tankage suitable for feeding is considerably firmer. The present price is about $4.30 per unit of nitrogen and 10 cents per unit of B.P.L., f.o.b. basis Baltimore. South American ground dried blood is also higher, figuring about $4.20 per unit of nitrogen, c.i.f. Baltimore.

Nitrogenous Material.—The price of this commodity has been marked up to $3.00 per unit of nitrogen, f.o.b. Baltimore, but without interest.

Sulphate of Ammonia.—It is reported that up to the present time fertilizer manufacturers have not been able to secure confirmation of their orders for their entire requirements of this material. Some of them fear that this year's production will be rationed out proportionately, particularly if any great tonnage is requisitioned for National Defense program. The price at which contracts are being booked, as previously announced, is $1.00 per ton higher than last year's starting point.

Nitrate of Soda.—While domestic producers announce there will not be any change in their price, in bulk, for delivery over the balance of this year, it is understood they only have a limited tonnage available. While importer's price schedule expired June 30th, up to the present time there has not been any announcement of prices for July and forward, although they are expected daily, at least, for July. In view of the materially higher market on burlap, it would not be surprising to see a proportionate increase to absorb the added cost of bags.

Fish Scrap.—The tonnage booked up to the present time is less than usual at this time of the year, and the nominal market remains unchanged at $5.30 per unit of nitrogen and 10 cents per unit of B.P.L., f.o.b. fish factories, for shipment "if and when made" and subject to catch.

Superphosphate.—Due to requisitioning of vessels which formerly carried phosphate rock, there has been a tremendous increase in freight rates, and in some quarters there is considerable concern that there will not be enough vessels available to supply superphosphate manufacturers in this section who are accustomed to taking shipments by water. None of them is equipped to take car deliveries, and it is questionable whether the railroads would have sufficient equipment available to make car deliveries. For this reason there is much concern

regarding supplies of this important ingredient which goes into the manufacture of practically all fertilizer. There were two advances during the past two weeks, making the present price $9.50 per ton of 2,000 lb., basis 16 per cent for run-of-pile, and $10.00 for flat 16 per cent grade, no charge for overage, both in bulk, f.o.b. producers' works, Baltimore. In view of the critical situation surrounding supplies of rock, most of the manufacturers will not book any new business, irrespective of price, in order to enable them to take care of their regular customers.

Bone Meal.—On account of increased ocean freights and scarcity of freight room, the market on foreign 3 and 50 per cent steamed bone meal ranges from $37.50 to $38.00 per ton, while 4½ and 47 per cent raw bone meal is priced at $36.00 to $38.00 per ton, f.o.b. Baltimore.

Potash.—As one of the important producers has not been in operation for quite a few weeks past on account of strike at their plant, it is beginning to look as though there may be a shortage of potash, as most of the producers have sold up their estimated production, but up to the present time there have not been any material increases in price. Most of the manufacturers placed their orders early, and deliveries will be forthcoming regularly from now on as the material is produced.

Bags.—For the past two weeks the market on burlap has been irregular, moving up one day and down the next, but the decreases have about offset the advances, so the net result of the fluctuation leaves the market where it was two weeks ago at $187.50 per thousand delivered Baltimore, for plain, new, 10-oz., basis 40, cut 54 in. There is not much interest being shown in burlap bags on account of the high cost of these as compared with paper bags, which will probably be more extensively used during the coming season.

ATLANTA

Cotton Products Market Unsettled by Henderson Statement. Little Change in Fertilizer Materials Market.

Exclusive Correspondence to "The American Fertilizer."

ATLANTA, July 1, 1941.

The statement last week by Leon Henderson that the prices on cottonseed oil were too high had an unsettling effect on the markets of quite a few commodities related to cotton and its products. Cotton, cottonseed oil, cottonseed meal, all reacted sharply to the Henderson statement.

It is now a question as to whether markets of this character which are largely influenced by the law of supply and demand can be artificially pegged with any ultimate hope of success.

There has not been any very radical change in the market on fertilizer materials as a whole, and prices are moving through a narrow range. The current shortage in nitrate of soda will probably be overcome before the summer is out after the top dresser season is over when supplies for the new fertilizer year will be accumulated. Superphosphate prices are firmer due to various contributing causes and it is now apparent that these upward price changes will probably hold throughout the coming season. The markets generally are as follows:

South American Blood.—$3.40 ($4.13½ per unit N), c.i.f.

Tankage.—$3.50 ($4.25½ per unit N) and 10 cents, c.i.f.

Domestic Nitrogenous Tankage.—Producers temporarily out of the market.

Acidulated Fish.—Nothing offered.

Dried Scrap.—$60.00 to $61.00, f.o.b. South Atlantic Fish Factories.

Sulphate of Ammonia.—Heavy bookings at

the current schedule of prices for the new season.

Nitrate of Soda.—Unchanged, with heavy spot demand and limited stock.

Cottonseed Meal.—Prime 8 per cent, $28.50 Memphis; Southeastern mills, $30.00.

CHARLESTON

Royster Buys Maybank Plant. Organics Scarce with Some Price Advances.

Exclusive Correspondence to "The American Fertilizer."

CHARLESTON, July 1, 1941.

It has just been reported that the plant of the Maybank Fertilizer Corp., Charleston, S. C., has been sold to F. S. Royster Guano Co., but the Maybank Fertilizer Corp. will continue to run a fertilizer plant at their Oakdene Warehouse at Charleston.

Nitrogenous.—Practically all sellers of this material have withdrawn from the market and are not willing to quote at this time.

Blood.—Around $3.50 ($4.25½ per unit N) Chicago, bulk; $3.35 ($4.07 per unit N) bagged c.i.f. Atlantic ports, where freight can be obtained.

Fish Meal.—This material continues scarce. It is very hard to obtain offers.

Cottonseed Meal.—This material has advanced quite considerably. 7 per cent material at $29.00, Augusta; 8 per cent at $30.00, Memphis.

Superphosphate.—This continues tight, as well as sulphuric acid.

CHICAGO

Sellers' Market on Fertilizer Organics Continues. Feed Materials Scarce and Prices Advance.

Exclusive Correspondence to "The American Fertilizer."

CHICAGO, June 30, 1941.

The general situation is unchanged from last advices. Sellers are maintaining a firm attitude and putting little, if any, offerings on the market. Their well sold-up position, and advancing prices of cottonseed and soybean meals are contributing factors in the organic producers' bullishness.

A very strong tone in feeding materials exists at this time, and an advancing tendency seems evident. Materials, as well as the finished products, are scarce and some mills are unable to accept prompt orders.

Nominal prices are as follows: High-grade ground fertilizer tankage, $2.75 to $2.80

($3.34½ to $3.40½ per unit N) and 10 cents; standard grades crushed feeding tankage, $3.85 to $4.00 ($4.68 to $4.86 per unit N) and 10 cents; blood, $3.40 to $3.50 ($4.13½ to $4.25½ per unit N); dry rendered tankage, 87 to 92 cents per unit of protein, Chicago basis.

TENNESSEE PHOSPHATE

Drought Affects Crops and Mining Operations. Strike by Truckers Hampers Rock Production.

Exclusive Correspondence to "The American Fertilizer."

COLUMBIA, TENN., June 30, 1941.

The unprecedented drought affecting the entire Tennessee phosphate area continues unbroken except for occasional showers bringing temporary relief to scattered sections. Pastures, lawns and new seedings have suffered terribly and serious effects are imminent in the almost complete absence of the usual June rains. Creek levels and rivers are almost at the stage not generally experienced until well into August and September. Some tobacco is flourishing by reason of fortunately being set out just ahead of showers, but most of it looks as if only an insignificant crop would be realized. Most of the small grain has been harvested with, as a rule, excellent quality, but very meager quantity. Corn is unusually spotted and the average of the crop looks very poor.

Water for phosphate washing is extremely short, and with continued dry weather, there will be great difficulty experienced by most plants in maintaining their ability to supply the heavy withdrawals that come on all of them from July 20th to October 15th. It seems likely that many users accustomed to waiting for their supplies until everybody else is ready to receive shipments, will wind up unable to get shipments.

The Charleston Mining Company had the misfortune to have the high earth embankment holding one of their largest settling ponds undermined by crawfish holes and the entire pond was precipitated into Sugar Creek. The greatest loss to the company is the millions of gallons of water in this critical time, together with the burying in the mud of some large earth excavating and handling equipment.

The mining operations of the International Agricultural Corporation at Southport have been interrupted by a strike of the truckers hauling from the mines twelve miles to the I. A. C. plant, but a large part of the tonnage had been moved before the truckers found out they could not get by at the price paid and struck for more. Also the stoppage of material coming in is coincident with the shortage of water, so it may not be so bad.

The Hoover & Mason construction work at their plant is proceeding with all possible dispatch. It is hoped to have it completed before the August demand for material comes. The TVA operations on Bear Creek and at Godwin, north of Columbia, are being pushed with great rapidity.

The Middle Tennessee Technical Society held one of its most delightful meetings at the Clarence Watson Camp on Duck River, attended by 24 members representing most of the phosphate operating companies in the field, who were served a wonderful fish fry, under the efficient charge of Wayne Carlton of the TVA. Considerable discussion of a highly technical nature was somewhat submerged under a flood of anecdotal oratory in which some technicalities were noticed, but mainly not.

The Ruhm Phosphate & Chemical Co. will hold its annual meeting of District Representatives on July 11th and 12th at Mt. Pleasant, probably attended by about one hundred coming from some twelve or fifteen states.

PHOSPHORIC ACID IN SOILS, AND FERTILIZER AND LIMING PROBLEMS IN CONNECTION THEREWITH

(Continued from page 7)

instances of well developed crown roots, despite the fact that the development above the ground had not proceeded nearly so far as in the deeply fertilized specimens. In the barley no such differences could be observed. In both the oats and the barley the seed roots were much further developed in the deeply fertilized than in the unfertilized specimens. From these observations it might be assumed that it is not necessary to apply a phosphate fertilizer as far down in the soil for oats as for barley. It must not be lost sight of, however, that in these experiments the soil was kept continuously moist throughout, right up to the surface. Such a condition rarely prevails in the field. Instead, the surface layer in the field is usually more or less dried out during the growing season. Under these conditions the crown roots develop right above the seed.

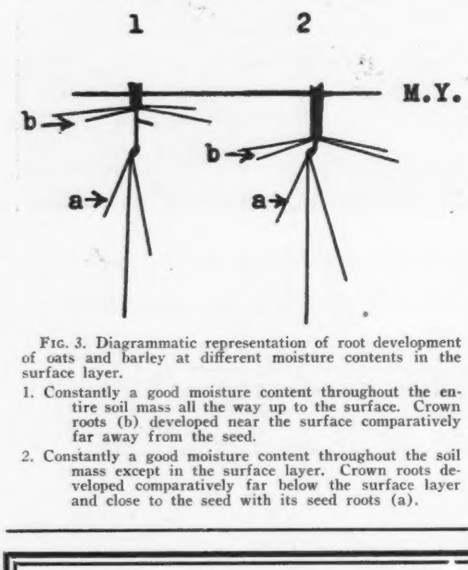


FIG. 3. Diagrammatic representation of root development of oats and barley at different moisture contents in the surface layer.

1. Constantly a good moisture content throughout the entire soil mass all the way up to the surface. Crown roots (b) developed near the surface comparatively far away from the seed.
2. Constantly a good moisture content throughout the soil mass except in the surface layer. Crown roots developed comparatively far below the surface layer and close to the seed with its seed roots (a).

When the experiments were concluded, both the oats and the barley were much further developed in the deeply fertilized than in the surface fertilized boxes. The unfertilized specimens were far behind the others, and this is only natural, since the phosphate condition of both of the soils employed was originally very poor. Both the unfertilized box and the box with the fertilizer distributed throughout the whole soil mass showed a network of roots very uniformly distributed throughout the whole soil mass. In the box in which the fertilizer was applied in a surface layer the branching of the roots was very considerable in the part below the surface layer, but where the roots penetrated further down there was almost no branching. Such a root system must be very ineffectual and very sensitive to drought. A surface application of a phosphate fertilizer would, therefore, probably diminish rather than increase the final crop, particularly if the soil is very poor in phosphate.

Where the fertilizer was disposed in two different layers (2 to 3 and 6 to 12 inches deep) there was a richly branching root system throughout both of these layers, while in the intermediate unfertilized layer the root branching was very insignificant.

In the box with the granulated superphosphate, compact accumulations of fine roots developed, squeezed together in bundles having a cross section of approximately one inch. If all of the soil was carefully removed, the root system looked like a birch tree which had shed all of its leaves and was full of so-called witches' brooms. Inside of each such root bundle there was found a phosphate particle which had not undergone any change whatever.

See Page 4

The roots which had penetrated down into the soil and had come close to such a particle had evidently benefited from the good phosphate conditions in their immediate neighborhood, and had put out a compact network of rootlets in order to take in the phosphoric acid which was easily accessible at this spot. The larger the phosphate particle was, the larger was the root bundle. It required a considerable amount of strength to tear such a root bundle apart. In this way the phosphate particle was well protected against external influences. The phosphate particle, therefore, remained uninjured in working the ground as long as such a root bundle was intact.

Table 2

Lactate Values at Conclusion of Tests

Soil Layer	(a) Not Fertilized with Phosphate	(b) Pulverized Superphosphate 2 to 8 in.	(c) Pulverized Superphosphate 0 to 2 in.	(d) Pulverized Superphosphate 2 to 3 in. and 6 to 8 in.
0 to 2 in.	1.7	1.6	2.4	1.6
2 to 3 in.	1.6	1.9	1.7	2.1
3 to 6 in.	1.6	2.0	1.6	1.7
6 to 8 in.	1.7	1.9	1.7	2.0

The phosphate content was, therefore, considerably higher in the phosphate fertilized layers. Where granulated phosphate was employed, the average lactate value between the root bundles was 1.7, while the soil closest to the root bundles showed a lactate value as high as 14.

Experiments with Pulverized and Granulated Superphosphate

In 1937 another series of experiments was carried out with pulverized and granulated superphosphate. The containers were of the conventional Mitscherlich type. The experiments were carried out without mixing any sand in the soil. The watering was carried out partly by sprinkling and partly from below as in the other box experiment just described.

The rest of the details of this experimental series, together with the harvest yields, are listed in Table 3.

The best phosphate effect was obtained with the granulated superphosphate. It made no difference whether it was mixed throughout the whole soil mass or only in the middle layer. With the pulverized superphosphate, however, the phosphate effect was best when mixed with the middle layer. With barley there was also a difference between the effect of the pulverized and the granulated superphosphate. The difference, depending on whether it was mixed throughout the whole soil mass or only in the middle layer, was greater than with oats. Thus, both the pulverized and the granulated superphosphate were more effective when mixed only in the middle layer than when mixed throughout the whole soil mass. The soils under consideration are close to the phosphate saturation point. It seems that the soil can more easily be kept saturated with phosphate for the requirements of the oats than for the requirements of the barley, and that the barley cannot fully satisfy its requirements of phosphoric acid except from the highly saturated phosphate particles which only the granulated phosphate can provide.

(To be continued in the next issue)

Table 3

Comparison of Pulverized and Granulated Superphosphates

	Pulverized Superphosphate Mixed in				Granulated Superphosphate Mixed in			
	Whole Soil Mass		2 to 4 in. Soil Layer		Whole Soil Mass		2 to 4 in. Soil Layer	
Crop*	Grain gm.	Stalk gm.	Grain gm.	Stalk gm.	Grain gm.	Stalk gm.	Grain gm.	Stalk gm.
Seger Oats	12	18	15	20	18	22	18	22
Golden Barley	2	3	4	10	16	19	18	18

*Without phosphoric acid, Oats—grain, 0.43; Stalk, 2.9.

TOMATO PLANT PRODUCTION IN THE SOUTH

(Continued from page 11)

certain other materials have looked very promising. One mixture is one part of Georgia peat moss and two parts of Spanish moss tailings. A similar combination of Georgia moss and sphagnum may be made.

One failure in packing plants with Georgia moss is to allow the moss to be too wet when packing. If this material is wetted and allowed to drain over night previous to packing, it will be found to work much better than taking it directly from the water and applying it to the plants.

The experimental data given in Tables 5 and 6 are a summary of work that has been done upon these materials and probably need a bit of explanation. None of the materials apparently had any toxic constituent. It will be noted that the pH value of most of the materials is very low. It is not felt that this is necessarily a desirable characteristic but is not definitely harmful. The percentage nitrogen content of the materials varies greatly but it is doubtful if much of this nitrogen is readily available and thus will not affect the plants materially. A material with a high ash content is not desirable but may not necessarily be harmful. The materials should have between 8 and 15 per cent moisture on the dry weight basis or otherwise it has been dried too thoroughly and is not likely to take up water readily. A material should take up six to ten times its weight in water.

The plant test consisted of placing 100 grams of the wet packing material on the roots of twenty medium-sized plants, wrapping and placing in 5/8 baskets in the shade in the greenhouse for four days. The plants were unpacked, carefully observed, weighed, dried and the moisture content obtained on them. It was noted that all of the plants gained weight during this four-day period and from the percentage of water in the peat when the plants were unpacked, many materials contained sufficient water to carry the plants even longer, while in three cases practically all of the moisture was used. The plants in these samples were beginning to wilt and would not have carried much longer.

The final column in Table 6 shows our rating of all samples as to their desirability as material for shipping plants.

Nutrients in the Peat

There appears to be merit in using nutrients in the peat. A number of materials have been experimented with in an attempt to ascertain the most desirable analyses and amount to use. Of the materials readily accessible in Georgia, a 4-12-4 mixture made from highly soluble materials used at the rate of 3 to 5 pounds per 50 gallons of water used in wetting the peat has given satisfactory results. The 4-12-4 mixture may be made approximately as follows:

	Pounds
Superphosphate, 18%	1350
Nitrate of soda, 16%	250
Sulfate of ammonia, 20%	200
Muriate of potash, 60%	140
Filler, preferably magnesium sulphate	60
	2000

It is believed that nutrients are very desirable for plants on the "hard" side but probably offers no advantage for plants on the "soft" side.

Summary

Tomato plant production in Georgia has become a thriving industry sending many millions of plants to the northern states each year. A brief summary of soil fertility work during the last four years is given. All fertilizer ingredients and other soil amendments are important in commercial plant production. Perhaps in no other industry is the need for a properly compounded fertilizer more essential.

It is recommended that from 400 to 750 pounds of 3-12-6 fertilizer mixture per acre be used on the average type of soil, with the quantity being governed by the strength of the soil. On other types of soil the 4-8-8 mixture appears to be very satisfactory. Both of these mixtures should be distinctly physiologically basic, that is, carrying as much finely ground limestone as the formula will permit. The nitrogen in the formulas should become available gradually as the plant progresses. This can be accomplished by varying the materials used.

BUYERS' GUIDE

A CLASSIFIED INDEX TO ALL THE ADVERTISERS IN "THE AMERICAN FERTILIZER"

This list contains representative concerns in the Commercial Fertilizer Industry, including fertilizer manufacturers, machinery and equipment manufacturers, dealers in and manufacturers of commercial fertilizer materials and supplies, brokers, chemists, etc.
For Alphabetical List of Advertisers, see page 33.

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Chemical Construction Corp., New York City.

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Chemical Construction Corp., New York City.

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Ashcraft-Wilkinson Co., Atlanta, Ga.
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Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

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BAG PILERS
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Link-Belt Company, Philadelphia, Chicago.

BEARINGS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

BELT LACING
Sackett & Sons Co., The A. J., Baltimore, Md.

BELTING—Chain
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

BELTING—Leather, Rubber, Canvas
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.

BOILERS—Steam
Atlanta Utility Works, East Point, Ga.

BONE BLACK
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Huber & Company, New York City.

BONE PRODUCTS
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
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Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

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BUCKETS—For Hoists, Cranes, etc., Clam Shell, Orange Peel, Drag line, Special; Electrically Operated and Multi Power
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.

BURNERS—Sulphur
Chemical Construction Corp., New York City.

BURNERS—Oil
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.

CABLEWAYS
Hayward Company, The, New York City.

CARBONATE OF AMMONIA
American Agricultural Chemical Co., New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.

CARS—For Moving Materials
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CARTS—Fertilizer, Standard and Roller Bearing
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

CASTINGS—Acid Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.

CASTINGS—Iron and Steel
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CEMENT—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

CHAIN DRIVES—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAINS AND SPROCKETS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAMBERS—Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

CHEMICAL APPARATUS
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

CHEMICALS
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Company, The, New York City.
Bradley & Baker, New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.

CHEMICALS—Continued
Huber & Company, New York City.
Phosphate Mining Co., The, New York City.
Wellmann, William E., Baltimore, Md.

CHEMICAL PLANT CONSTRUCTION
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHEMISTS AND ASSAYERS
Gascoyne & Co., Baltimore, Md.
Shuey & Company, Inc., Savannah, Ga.
Stillwell & Gladding, New York City.
Wiley & Company, Baltimore, Md.

CLUTCHES
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CONCENTRATORS—Sulphuric Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

CONDITIONERS AND FILLERS
American Limestone Co., Knoxville, Tenn.
Dickerson Co., The, Philadelphia, Pa.
Phosphate Mining Co., The, New York City.

CONTACT ACID PLANTS
Chemical Construction Corp., New York City.

COPPER SULPHATE
Tennessee Corporation, Atlanta, Ga.

COTTONSEED PRODUCTS
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

CRANES AND DERRICKS
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corp., Chicago, Ill., and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

CYANAMID
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

DENS—Superphosphate
Chemical Construction Corp., New York City.
Stedman's Foundry and Mach. Works, Aurora, Ind.

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DISINTEGRATORS
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

DRYERS—Direct Heat
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.

DRIVES—Electric
Link-Belt Company, Philadelphia, Chicago.

DUMP CARS
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

DUST COLLECTING SYSTEMS
Sackett & Sons Co., The A. J., Baltimore, Md.

ELECTRIC MOTORS AND APPLIANCES
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

ELEVATORS
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ELEVATORS AND CONVEYORS—Portable
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

ENGINEERS—Chemical and Industrial
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ENGINES—Steam
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

EXCAVATORS AND DREDGES—Drag Line and Cableway
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Link Belt Speeder Corp., Chicago, Ill., and Cedar Rapids, Iowa.

FERTILIZER MANUFACTURERS
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Farmers Fertilizer Co., Columbus, Ohio
International Agricultural Corp., New York City.
Phosphate Mining Co., The, New York City.
U. S. Phosphoric Products Division, Tennesee Corp., Tampa, Fla.

FISH SCRAP AND OIL
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

FOUNDERS AND MACHINISTS
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GARBAGE TANKAGE
Wellmann, William E., Baltimore, Md.

GEARS—Machine Moulded and Cut
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GEARS—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

GELATINE AND GLUE
American Agricultural Chemical Co., New York City.

GUANO
Baker & Bro., H. J., New York City.

HOISTS—Electric, Floor and Cage Operated, Portable
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.

HOPPERS
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

IMPORTERS, EXPORTERS
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

IRON SULPHATE
Tennessee Corporation, Atlanta, Ga.

INSECTICIDES
American Agricultural Chemical Co., New York City.

LACING—Belt
Sackett & Sons Co., The A. J., Baltimore, Md.

LIMESTONE
American Agricultural Chemical Co., New York City.
American Limestone Co., Knoxville, Tenn.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

LOADERS—Car and Wagon, for Fertilizers
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Acid Making
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Duriron Co., Inc., The, Dayton, Ohio.
Fairlie, Andrew M., Atlanta, Ga.
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Coal and Ash Handling
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Elevating and Conveying
Atlanta Utility Works, East Point, Ga.
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

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MACHINERY—Grinding and Pulverizing
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Power Transmission
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Pumping
Atlanta Utility Works, East Point, Ga.
Duriron Co., Inc., The, Dayton, Ohio.

MACHINERY—Tankage and Fish Scrap
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MAGNETS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MANGANESE SULPHATE
McIver & Son, Alex. M., Charleston, S. C.
Tennessee Corporation, Atlanta, Ga.

MIXERS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

NITRATE OF SODA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Company, The, New York City.
Bradley & Baker, New York City.
Chilean Nitrate Sales Corp., New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

NITRATE OVENS AND APPARATUS
Chemical Construction Corp., New York City.

NITROGEN SOLUTIONS
Barrett Company, The, New York City

NITROGENOUS ORGANIC MATERIAL
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
DuPont de Nemours & Co., Wilmington, Del.
Huber & Company, New York City.
International Agricultural Corp., New York City.
McIver & Son, Alex. M., Charleston, S. C.
Smith-Rowland Co., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

NOZZLES—Spray
Monarch Mfg. Works, Philadelphia, Pa.

PACKING—For Acid Towers
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

PANS AND POTS
Stedman's Foundry and Mach. Works, Aurora, Ind.

PHOSPHATE MINING PLANTS
Chemical Construction Corp., New York City.

PHOSPHATE ROCK
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Charleston Mining Co., Inc., Richmond, Va.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
Phosphate Mining Co., The, New York City.
Ruhm, H. D., Mount Pleasant, Tenn.
Schmaltz, Jos. H., Chicago, Ill.
Southern Phosphate Corp., Baltimore, Md.
Taylor, Henry L., Wilmington, Del.
Wellmann, William E., Baltimore, Md.

PIPE—Acid Resisting
Duriron Co., Inc., The, Dayton, Ohio.

PIPES—Chemical Stoneware
Chemical Construction Corp., New York City.

PIPES—Wooden
Stedman's Foundry and Mach. Works, Aurora, Ind.

PLANT CONSTRUCTION—Fertilizer and Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

POTASH SALTS—Dealers and Brokers
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, Del.
Wellmann, William E., Baltimore, Md.

POTASH SALTS—Manufacturers and Importers
American Potash and Chem. Corp., New York City.
Potash Co. of America, Baltimore, Md.
United States Potash Co., New York City.

PULLEYS AND HANGERS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

PUMPS—Acid-Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

PYRITES—Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., New York City.
Jett, Joseph C., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

QUARTZ
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

RINGS—Sulphuric Acid Tower
Chemical Construction Corp., New York City.

ROUGH AMMONIATES
Bradley & Baker, New York City.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

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SCALES—Including Automatic Bagging
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SCRAPERS—Drag
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.

SCREENS
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SEPARATORS—Air
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Including Vibrating
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Magnetic
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHAFTING
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHOVELS—Power
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corp., Chicago, Ill., and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

SPRAYS—Acid Chambers
Monarch Mfg. Works, Inc., Philadelphia, Pa.

SPROCKET WHEELS (See Chains and Sprockets)

STACKS
Sackett & Sons Co., The A. J., Baltimore, Md.

SULPHATE OF AMMONIA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Company, The, New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Hydrocarbon Products Co., New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

SULPHUR
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Freeport Sulphur Co., New York City.
Texas Gulf Sulphur Co., New York City.

SULPHURIC ACID
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.

SULPHURIC ACID—Continued
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE—Concentrated
Armour Fertilizer Works, Atlanta, Ga.
International Agricultural Corp., New York City.
Phosphate Mining Co., The, New York City.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

SYPHONS—For Acid
Monarch Mfg. Works, Inc., Philadelphia, Pa.

TALLOW AND GREASE
American Agricultural Chemical Co., New York City.

TANKAGE
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Smith-Rowland, Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

TANKAGE—Garbage
Huber & Company, New York City.

TANKS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons, Co., The A. J., Baltimore, Md.

TILE—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

TOWERS—Acid and Absorption
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

UNLOADERS—Car and Boat
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

UREA
DuPont de Nemours & Co., E. I., Wilmington, Del.

UREA-AMMONIA LIQUOR
DuPont de Nemours & Co., E. I., Wilmington, Del.

VALVES—Acid-Resisting
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

WHEELBARROW (See Carts)

ZINC SULPHATE
Tennessee Corporation, Atlanta, Ga.

ALPHABETICAL LIST OF ADVERTISERS

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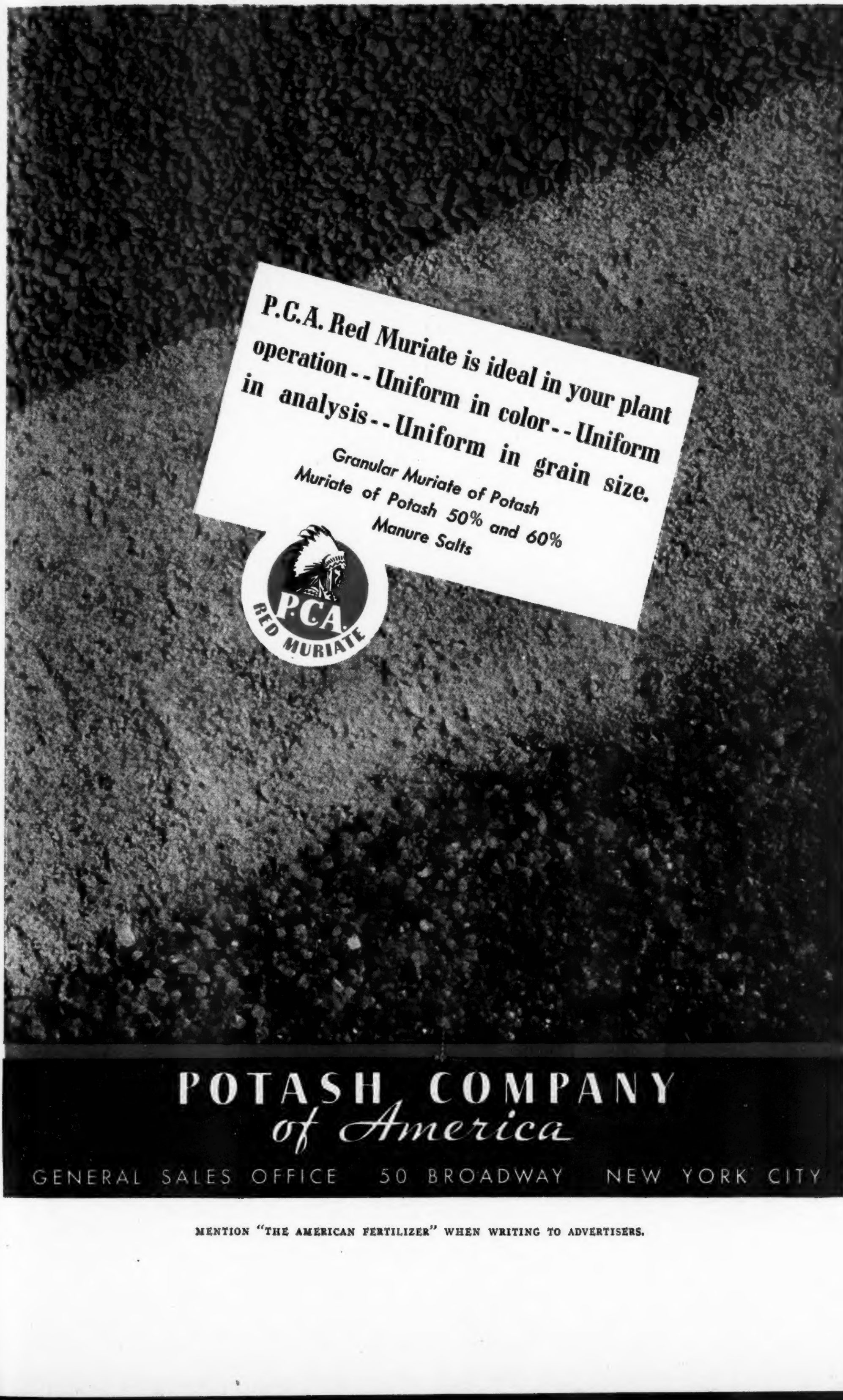

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